

# Greenbank Electronics

Our Ref: INTKGEN/8807

## GENERAL INFORMATION ON INTERAK

(Particularly addressed to the "build it yourself" client)

### **What is Interak?**

Interak is a system of printed circuit boards mostly of our own manufacture, designed to the highest standards for industrial control applications, educational research, and the like, and usually supplied built and tested. Although industry is where the money is, we still have a soft spot for the individual "home" user, working virtually on his kitchen table, and who is usually denied products of the superior quality and design used in industry. If you are such a user we are willing to sell the bare boards to you and all the technical documentation you need to build a system. You can supply your own parts or you can buy the components from us.

Our concern for the "home" user as defined above is not entirely as altruistic as it sounds. It has been our experience that a lot of people who work and specify electronic products in industry and higher education, sometimes also have a home to go to. If we look after the little man who is working to a tight budget, then you can be sure that we will look after you equally well if you work in industry and have hundreds or thousands of pounds to spend on a dedicated control application.

### **Interak Can Be Commenced With the Minimum of Outlay**

You will be pleased to learn that INTERAK can be commenced with the minimum of outlay, so you can build it at a pace which is agreeable to your enthusiasm and the contents of your wallet (or Access or Visa, or you can even, subject to status, purchase on account - with **no** interest charges!)

The bare boards range in price from around 10.95 pounds to something over 20.00 pounds (prices + VAT). You can supply any or all of the parts yourself; hardly without exception they are readily available from a variety of sources, but of course we prefer it if you buy the components from us, if you buy them from anyone. All the parts are individually available or in kit form, whatever you prefer.

### **No Special Chips**

An outstanding feature of the Interak design is that there are no "surface mount" chips, ASICS, ULAs, Custom Chips, PLA Devices, and the like. (In case this jargon is confusing you, I had better explain that we are here referring to the type of special miniaturised, highly integrated chips which are "de rigeur" in a typical modern computer. For example Amstrad computers are full of unique Amstrad chips, IBMs with special IBM chips, Acorns with Acorns, Atari with Ataris, Commodore with Commodore, Compaq with Compaq, and so on. They are often "surface mount" types which are glued to the surface of the pcbs before being soldered with infra red beams, lasers, or high boiling point vapours). The benefits to the manufacturer using custom chips are immense: The manufacturer can control

the supply of the components, the secrets inside can be kept secret from the competitors (and incidentally the users), and when the manufacturer is good and ready the chips can be rendered obsolete overnight. The benefits for the manufacturer are not quite the same benefit to the user, especially our type of user whose primary purpose is to learn and understand what's going on inside.

### **For Active Enquiring Minds**

Interak is made for those people with active enquiring minds who have to know what goes on inside anything they possess. You may think this means young people, but it has been my experience that it is our retired clients who have the most enquiring outlook. It seems that young people - with a few exceptions of course - have been programmed to think that technical experimentation is not for the likes of them. Even in school or college university classes, where they're supposed to be learning the subject of computing, they have to call the man in to fix the computer when it breaks down!

In days gone by, young people were encouraged to take the back off TV sets, watches, build their own two way tin can intercom, crystal sets (winding the coils on the cardboard tubes found on the inside of toilet rolls), and so on. If you are young and have been brainwashed into thinking that you are only capable of buying things, not making them for yourself, then we can help you realise your proper potential.

In computing particularly, you have to know what goes on inside. There can be few people nowadays who do not own a "home" or "personal" computer of say the Sinclair, Amstrad, Acorn, Commodore general persuasion. No doubt they (or you did if you were one of them) eagerly took the computer home, loaded the example tape or disk of games, and decided at once to embark on writing a program of their own . . . only to meet with dismal failure. The reason is that the programs have to be written with a full knowledge of the hardware, which inevitably has to be kept secret if it is contained in those special undocumented custom chips of which we spoke earlier. You might just as well learn to drive a car wearing a blindfold and not being allowed to touch the pedals! Trying to operate a computer without full circuit diagrams describing its working is tantamount to the same thing.

We only ever seem to sell people their **second** computer - never their first. It is the household names in computer supply who know how to pick up all the sales for the "first" computers (that is how they became household names!) The newcomer to computing can only make a judgement on what is "best" by the old formula: multiply Megahertz by Megabytes and divide by total cost - the result is a figure which tells you how good the computer is! (Rather like evaluating the worth of the Mona Lisa by multiplying the height by the width of the canvas and dividing by the thickness of the paint.)

### **Documentation Available Separately**

All of the documentation for Interak is sold separately, and can be purchased in advance of the boards and components, so that you may judge for yourself how complex the task is going to be and whether or not you can cope, before it is too late.

### **Go at your Own Pace**

Interak is a project which can be taken as quickly or as slowly as you prefer. You could be up and running in a week or so, but some of our users have simply built Interak as a recreation, spreading over several years!

An annoying aspect of living in the late 20th Century is the prevalence of shoddy workmanship and materials, the result of our "throwaway" life style. We all must have bought an expensive item of consumer equipment at one time or another and had the pleasure ruined by some poor quality workmanship - say the button which pops off a designer label jacket, or the soles which come unstuck from your high technology training shoes on your first marathon. Take them back and the supplier will say that people just won't pay the extra for quality materials. Who says they won't? Who was ever consulted before the manufacturer decided to substitute cheap glue for hand stitching, plastic for metal, tat for quality? Of course we all want things to be made inexpensively, but we never asked for them to be **cheap**.

I have been quite surprised to observe penny-pinching in the design of quite expensive computers. Cases made of thin plastic when they should be of steel. Printed circuit cards waving in the breeze because proper card guides would have cost a few pence more. No support for connectors on the system "mother board". Non polarised connectors used (which can be disastrously misconnected) for the same reason. Nobody wants to waste money, but it is not a waste of money to do a job correctly, with the proper materials for the job.

### **Solid Engineering Construction**

"Interak" stands for "International Size - Rack Mounting Construction"; Interak is designed to have a traditional, solid engineering construction - something of which to be proud. Indeed some users have seriously requested that clear Perspex panels be let into the case so that the insides of the computer are permanently on display, they are so proud of them! The case and rack we use is of the industrial type: a 19" 3U rack (sometimes called a card frame, or cage, or crate) mounted in a strong metal case. To get the best enjoyment from your computer it is not essential to perform a tap dance on the finished unit, but it is reassuring to know that you could if you wanted to! Of course you may not agree with our general views and may have the opinion that it is a waste of money to spend it on items which do not add performance. The American phrase is "more bangs per buck"; no bangs come from the case and the rack, so waste no money on that. This is a perfectly acceptable point of view - different from my own, but that does not make it invalid - and of course the user who holds a different opinion from mine can use the Interak cards in a way which suits him; there is no compulsion whatever to use the rack and case we recommend.

### **Modular Construction**

Plug in circuit boards and modular construction are used throughout. Up to 13 cards, spaced on a one inch pitch can be plugged into the system rack, using gold plated connectors. In the short term this is not the cheapest way, but in the long term it is: In the short term the cheapest possible system is to have all the components for the whole computer on one single

circuit board - in this way there is no need for connectors to connect one module to another, there is no need for buffers to allow one card to drive several others, indeed there is obviously also no need for a system rack if there are no cards to plug in. That it is the cheapest method (for bangs per buck) is demonstrated by the fact that virtually all of the cheapest home computers are inevitably constructed in this fashion.

The trouble with such products is that everything you could possibly want has to be allowed for in the original design, and eventually the whole system on a single board has to be discarded if one part of it becomes obsolete. As an example of this I can take a computer which was very popular a few years back. It was hailed as having everything you could possibly want for all time in a computer. Numerous VDU display modes, wonderful graphics, Analogue to Digital converters, parallel ports serial ports, built in BASIC, high speed MPU bus interface, tape, disk, massive 32K RAM. And now the manufacturer concerned has twice replaced the computer which had everything you ever would need. (I must not mention this computer by name for fear of precipitating a rise in blood pressure in the computer-owning population at large so perhaps its initials will give you a clue: B.B.C.)

I do not mean to imply that the type of computer I have been describing was a bad design, or even a bad buy - I am only pointing out the limitations of a non-modular design. Who could have foreseen that one day 32K of RAM would no longer be looked on as "massive", or that BASIC would become a very inferior language, not used at all in serious applications, or that high density 3.5" floppy disks would be invented? Interak was invented before the BBC computer, indeed before the Acorn Atom which came before, and the card system they had before that, and Interak still is not obsolete. Interak is rather like the axe which has been in a family for generations - it has only had seven new handles and three new heads! For example the computer from which Interak was developed had six cards to make up its VDU interface, and had 256 bytes of RAM. I well remember the thrill of achieving 2K of RAM on a single plug in card, and thinking then I would never run out of RAM again! It is because the basic structure and concept of a modular plug in card system is so sound that it can still be running when other, ostensibly more advanced, computers have come and gone. Even ten years or more on, there is still no reason to suppose that Interak has even started to approach its limits, there seems no limit to its future expansion.

It was once said many years ago that there would be a top limit on the size of mainframe computers - because there would not be a power station large enough to power the heaters of the valves which would be required for its memory! We once might have thought that the maximum RAM for Interak was 3K, because 256 bytes of RAM was the most which could fit on one card. Then came the 2K RAM card (MXA-2 for those old hands who remember the system then), the 8K RAM card (MXA-3), the 16K (MXD-2) and the present 64K (DRM-64). There is no reason to suppose that this process will not continue, and it is easy to engineer upgrades in performance with the plug in cards of Interak, but impossible after a certain stage in a "one-board" system. Eventually you just have to throw a one-board computer away, together with all the experience and knowledge you gained on it. This then is the reason I say the modular plug in construction is the least expensive in the long term even if it is not in the short term.

### **Tens of Thousands Already Sold**

Tens of thousands of the Interak boards have been sold. Granted this is not many by global standards (Amstrad for example aim to sell that quantity of their product in a day), but it is a quite respectable quantity considering its specialised nature. It may be the case that the number of people who watch "Neighbours" on TV is ten times the number who watch "Horizon", but that does not necessarily mean that "Neighbours" is the better programme. I think you should be your own man and do what you want to do regardless of what the sheep on your block may think; if your colleagues at work make fun of you for thinking you can build your own computer, then take comfort from the fact that one day the laugh will be on them!

Mind you, just in case you are still nervous about doing things for yourself, and would be comforted to be one of the crowd, here are some reassuring statistics: One of the most popular group of personal computers in the world was (is) the IBM PC/XT/AT range. IBM has now discontinued that range in favour of a new design with a new bus and operating system (the PS using OS/2), but there are many "clones" still in manufacture. During the five years or so they were current something like 10 million IBM PCs and clones were manufactured. Not bad, but think about this: in this year alone 50 million Z80's will be made, so you are most definitely not alone if you are building with a Z80.

### **Flourishing Users Group**

Although it is perfectly permissible for you to build your Interak computer in isolation there are some users who like to compare notes with others. There is a flourishing Independent Users Group called "Interaktion" which circulates an occasional newsletter. So far the newsletter has run into 16 issues, which is most gratifying (most user groups begin with grand ideas, and then gradually fizzle out by issue 5 or 6 of their newsletter, this one, like Interak itself, seems to be immortal).

It is a sad commentary on the state of dependency to which the computer using population has sunk in that the fourth question they ask (the first three are "how many Megabytes?", "how many Megahertz, and "how much does it cost") is "what software is there?" I suppose the idea of users writing their own programs is too fanciful a notion to contemplate in these enlightened times? How do you like being divided into a world of "them" and "us"? "Them" can write programs, "us" can't! I have good news for us: with Interak us can!

### **Plenty of Software**

As it happens Interak is particularly well placed regarding the availability of prewritten software. The disk operating system used is CP/M Plus, the current version of CP/M which was invented in those naive days when copy protection had not been invented and was the first step towards the goal of writing programs in such a way that (within reason) any program would run on any other CP/M computer, without copy protection or other hindrance.



The big hardware and software suppliers soon realised their error and the trend now is towards the exact opposite: for the manufacturer the ideal is software that runs on only one machine and on no account can be transferred to another! Fortunately for the CP/M fraternity the cat is out of the bag; no matter how much modern computer manufacturers would like to see it dead, CP/M will not lie down and die. What has been invented cannot be uninvented and the software written and in the public domain already cannot be unwritten.

The Interaktion Users Group has a library of public domain programs which can be copied at a modest charge (which goes into the group's funds, it is a non-profit making organisation) for any member who wants a copy. There is also a very large organisation (thousands of members) you can join called the CP/M UK User's Group, which has a library of several hundred disks, with thousands of programs available to its members. (I have asked their permission to hand out their publicity material to all enquirers of Interak, but they have refused it, on the grounds that they are an independent group who cannot be seen to have any connection with a commercial organisation: strictly amateurs only, and no profit making!)

Because CP/M has been established so long pretty well any program or language you might want is bound to exist. The difficulty is finding it, because most software suppliers prefer to stock things which are popular with the ordinary computer magazine reading man in the street, where they can make a quick turnover and high profit. Just like the cabinet maker who has to search for a source of special veneer for a quality job, instead of using some stick on wood-grain effect plastic from Woolworths, the CP/M users have to obtain their software away from the high street.

### **Languages, Applications**

CP/M Plus is supplied with a relocating macro assembler and linker, and various other utilities, so programming in assembly language (or even raw machine code if you want to do things the very hard way, say for educational purposes) can be begun at once. Languages such as BASIC (interpreters and compilers), Pascal, Forth, etc are common, and somewhere between the two is "C". Applications such as accountancy, recipes, cataloguing, address books and the like are best served by a database program such as Ashton Tate's dBase II. For word processing Micropro's "Wordstar" is about the ultimate, (I am pleased to see they are continuing to support CP/M users because they have just produced version 4 for use with CP/M; it has lots of new features such as built in mail-merge, spelling checker, more comprehensive printer support etc).

### **Tape or Disk**

Although the use of ordinary audio cassette tape for storing programs and data is now very much out of favour for "serious" applications we think there is still a place for cassette operation, and so we still continue to offer a cassette tape interface. One benefit is in dedicated systems designed to do some particular job, eg an automated weighing scale, or gathering data on stress analysis in civil engineering, or weather station data logging in a field biology experiment and so on. In such systems, the expense of disks, the necessary power supply, and the CP/M disk operating system cannot be justified. Disks come into their own when large amounts

of essentially random access information need to be close to being "on line" at all times.

The tape interface is also used as a stop-gap measure for those Interak enthusiasts whose spare cash does not match their enthusiasm. They obviously want to get started doing something practical but funds do not run to the purchase of all the disk paraphernalia at the outset. Almost everyone can lay their hands on a tape cassette recorder for their first experiments and can thus postpone the upgrade to disks until they are ready. If a tape interface has been rendered obsolete by a later upgrade to disks the board will still have its uses, if not needed for maintaining access to the back up of work which have gone before. One use would be a conversion to a standard RS-232 style of interface, another would be as a means of communication between two Interak computers, by direct connection or even via a telephone line. The accepted method of serial communication between computers is using "modems", but at 2400 baud a direct connection using the tape interface would show the average 300 baud or 1200 baud modem a thing or two!

Thanks to the modular design of Interak, disks can be added to a tape-based system just as easily as building in disks from the outset.

The favoured disk size for Interak is 3.5", double sided, double density, and this is the size on which we supply the CP/M Plus operating system, and on which the Interaktion User Group supplies copies of disks from its library. However the disk interface card is capable of interfacing to a variety of disk drives, 3", 5.25", 8", single density or double density, single sided or double sided, 37 track, 40 track, 77 track, 80 track (sometimes called quad density, although we do not favour the term in this context), and 3.5" high density (2 Megabyte 80 track). With an amount of hardware and software fiddling a mixture of 4 assorted drives can be used in the one system, and with even more fiddling (adding extra disk select lines for example) the system could support many more than the normal 4 drive "maximum".

Hard disks are not available at the moment, but there is nothing in the Interak design which will prevent hard disks being added later, if demand warrants that we produce a hard disk interface card.

### **Expansion Potential**

The natural amount of RAM in a Z80 system is 64K, since the Z80 has 16 address lines (each line can have two states, 0 or 1, and two raised to the power 16 is 64K). 64K of dynamic RAM is contained on the Interak DRM-64 card. For those users who have been limited in the past by home computers which have inadequate amounts of RAM it is worth mentioning that the amount of RAM in a system is not in itself a limit on what the computer can do. Remember a microprocessor reads from one and only one location at a time and it hardly matters whether this is one out of 1K, one out of 64K, or 1 out of 16 Megabytes. The limit is the disk capacity. For example in a typical home computer with 128K of RAM when word processing you could easily run out of RAM space, yet you could easily edit a file of many hundreds of Kilobytes in a CP/M system such as Interak. (Looking after the transfers of data between RAM and disk is one of the jobs which CP/M Plus is paid to do!)

The basic structure of Interak was designed many years ago in a way which allows it to take advantage of what might happen in the future. The address lines defined on the backboard allow for a memory space of 16 Megabytes (ie 256 times 64K!) Interak has had to wait many years for the chip manufacturers to catch up. An exciting new development from Zilog (who invented the Z80 originally) is their latest enhancement, the Z80280. This successfully performs the balancing act which allows it to remain completely compatible with the Z80, yet allows access to a worthwhile group of performance enhancements. One, the 16 Megabyte addressing range, we have already mentioned; another is the addition of new operating modes, such as built in hardware multiply. The maximum clock rate of the Z80280 is 20 MHz although we understand there are plans to increase this to 50 MHz as production techniques develop. Nevertheless the Z80280 can still work happily in existing systems because it has a method of scaling the bus clock, so that it runs at "normal" speed whilst a bus transaction is in progress, and at supersonic speed when it is performing internal operations.

The world of computing is one where big profits are made by big companies playing for big stakes, and the amount of investment in specialised "custom" chips, roboticised "surface mount" assembly lines, etc, runs into hundreds of thousands, maybe billions of dollars. You might be surprised to learn then that ordinary mortals are still capable of building a computer with no more than a measure of common sense, a few simple hand tools and a kitchen table! The difference is that you will have to use several chips where the robot uses one, you will have to solder all the joints individually where the robot does them all in one pass with a wave of solder or a blast of infra red, but another difference is that you will be able to learn from what you are doing; only the designer of the robot version truly knows what is inside the finished product.

### **Practical Use of Technology**

The value of building at a practical technological level cannot be over emphasised. If you have an accident with your Interak and need to replace some part, you can do it. In many modern computers the only way to fix a fault is to replace a whole assembly - even a complete circuit board, and once that product goes out of production (and such is the pace of leading edge technology often even a circuit board is not a legitimate spare part) - you have to throw away the whole computer! I am not exaggerating - to see the criminal waste of money and resources just visit a computer "junk" shop and see how much is obsolete within say 5 years of manufacture.

If it is (relatively) simple technology it is so much easier to understand and work on. I am put in mind of a relation of mine who bought a new car with a microprocessor controlled electronic fuel injection system. (Mine has a carburettor). Needless to say, within a month or so it had broken down, 200 miles away in busy London rush-hour traffic. Equally needless to say, no mechanic could fix it, and it had to be transported back to the dealer and wait several weeks until a new circuit board (costing 400 pounds, luckily it was still under guarantee) could be obtained. If a brand new product is so close to being unrepairable within weeks of purchase, what chance is there in years to come? I am afraid the answer that it doesn't matter a hoot, because research shows that most new cars purchased



are replaced by their owners within three years. This may well be perfectly valid commercially, but from an engineering point of view the concept of "use it and throw it away" does not impress me.

You might be concerned that you have insufficient specialised technical knowledge to construct a computer. That could be so with any computer but Interak. Interak is one of the few computer systems (maybe the only one, but let me know if you are aware of any others) which is sold as bare printed circuit boards, individual components, and for which circuit diagrams, circuit descriptions, parts lists etc, are readily available - in advance if you require them.

### **Personal After Sales Service**

I should stress that you can build Interak with complete confidence that it will work. Greenbank Electronics operates a full after sales service: not only do we guarantee our workmanship, but we guarantee yours as well! Although we reserve the right to charge for rectifying faults or breakages caused by the customer, we have never seen fit to exercise this right during all the time we have been supplying Interak!

It is a great help to satisfactory construction if you can make a good soldered joint, but even if you can't when you start, you will be able to when you finish - there are hundreds of joints to be made on each one of our circuit boards! Of course we recognise that there are plenty of people who do not enjoy soldering, and for them we offer a constructional service. It is normal for us to supply our industrial customers with built and tested circuit boards (they don't like soldering either!) and of course we can do the same for you as a private individual. The fee is in the order of 10.00 to 35.00 pounds per board, depending on the complexity.

You may be suspicious that this after sales service is too good to be true, but if you think about it, you will see there is method behind our madness. Any other computer but Interak is sold in one big lump - once the manufacturer has your money he knows you won't be back again: either the computer will work well and never goes obsolete (in which case you will be delighted, but of course you will not need to buy another), or it will be useless and unreliable (in which case you **definitely** will not buy another!)

We of course do not necessarily sell Interak as one single lump. You might start investing a few pounds for some manuals, then buy a CPU card, then a few sockets and ICs. We hope that you will be buying small amounts from us regularly for years to come, and if we deny you enthusiastic after-sales service anywhere along the line, then we know what our punishment will be! There are about 25,000 customers and enquirers on our list so it is a great help if people can only come to us if they really do have some particular difficulty, but that is not to say we do not enjoy a chat with anybody and everybody - it is just unfair on the next caller if you hog the telephone line for long periods.

I have always preferred to be a big cog in a little machine rather than a little cog in a big machine, and the benefit this gives you is that I can personally be available to any one who needs me. Big computer companies are just as keen to provide good after sales service, but the scale of their organisation means that the top men inevitably have to be isolated from the

customers. I can just about look after 25,000 of you, (if you space yourself out over the several years of Interak, and don't all ring at once!) but ten or one hundred times as many would be just too many to cope with individually.

Greenbank Electronics is a small privately owned firm, and I think this in itself makes for better service and enthusiasm than can be achieved in a public limited company. You can't serve two masters, and once there are stock market shareholders looking for an ever increasing profit, the customers of the company simply become sources of profit to the shareholders. For example the shareholders wouldn't mind at all if a range of computers were rendered obsolete overnight, just so long as they could be sure the new range would bring in bigger profits. You often find a share price on the stock exchange goes up when a company announces a new model.

Commercial pressure is always on to produce new models and gain market share, even though there is nothing wrong with the old ones. It is the kiss of death to a computer for a new model to be introduced - I have seen yesterday's computers (some even brand new and boxed) for sale at Radio Amateur Rallies for 15 pounds, 25 pounds and so on, Orics, Lynxs', Sinclairs, Acorn Electrons, Memotechs, MSXs, Nascoms, VIC 20s, Dragons, Einsteins, Superbrains, Ohio Superboards, Ataris, Advances, One Per Desks, Microtans, Commodore Pets, TRS-80s, Juliet Aces, Compukit 101s, etc, etc. All of these were 'selling well until the fateful day that the powers that be decided that they would be obsolete, and from that moment they were worthless.

### **Designed by Engineers not Accountants**

Interak is above all this foolishness. From the outset Interak was designed by engineers not accountants, and nowhere in the design is there a feature which will automatically cause it to become obsolete in a given number of years. It is a sad commentary on the current philosophy of computer design today that a computer (which could be thought of as everlasting, having as they do very few moving parts) lasts for less time than say an office typewriter. Talking of which, I have seen typewriters built pretty well at the beginning of the century, which are still in perfect working order, whereas recent electronic models have had to be scrapped, as being beyond economical repair.

In a nutshell: if you buy a "ready made" computer now you will almost certainly have to scrap it within 5 years, but if you build one for yourself, using standard parts, then you can keep it for a lifetime. Of course we cannot bury our heads in the sand, and halt progress; nor would we want to. The point is that by using modular design, if the worst comes to the worst and a module does become obsolete through the vagaries of the IC manufacturers, then at least it is only that module which will need replacement, not the whole computer!

## Security of Supply

Greenbank Electronics has been established for nearly 20 years, ie before many computer manufacturers were even in existence, and have been designing and selling modular computers of the Interak design for about 10 years. Ask any supplier about continuity of supply and the obsolescence of their products and they will all make comforting noises, but with Greenbank Electronics you can look back at our record. We have kept our head when all about us have been losing theirs for 10 or 20 years already - so we can be pretty confident about the future.

Harping back to our old subject for a moment, the use of Custom Chips, ASICs, ULAs etc: The wisdom of the Interak design will be seen in the future, because Interak can go on and on, come what may. For example if you have a Tangerine "Oric", what are you going to do if you need a special "Oric" chip tomorrow? Orics are dead and buried, so if the main chip fails, or you need any other spare part, you may just as well throw the whole computer away. It probably has not happened yet, but eventually the same will go for Acorn Electrons, early model BBCs, early model Amstrads, and so on. The facile answer is that when it breaks down you simply go out and buy another one - that's not much of an answer to me, and if I had designed such a system I should be ashamed to call myself a professional engineer and designer.

One of the best selling Interak boards is ironically one which has no circuits on it. This is the DIP-1 prototyping board; it is the same shape and size as all the others with and has an edge connector to plug into the system rack, but it allows you to build your own circuits to your own (or a copied) individual design, and plug them into the computer. We are delighted when an Interak User has progressed to this stage - many of you building designs of your own first came to us with an uncertain voice "do you think I could build a computer, I don't know very much about electronics?" Several years on, look at you now!

## Success Stories

Interak is also a help in furthering a technical career. No names, no pack drill, but I can quote several histories where Interak has altered peoples' lives:

One was a radio technician in the Merchant Navy, who came back from the sea, and had a mundane job with a computer company, fixing computers by the traditional method of board swapping. Of course not all faults respond to this technique, and this person was able to use the knowledge he had gained with Interak to perform miracles on the main frames (bear in mind the principles of computing are the same in a mainframe as they are in a Z80, and even the chips are sometimes the same - the speed and efficiency of Z80-style chips makes them ideal for relatively simple tasks, aiding the mighty mainframe in its ruminations). To cut a long story short, he now has an important job in the training section of a large international mainframe computer peripherals manufacturer, all thanks to Interak.

Similarly, the schoolteacher who was chosen for a regional director of computing job, because he spoke so knowledgeably at the selection interview. The other candidates were all experts on how to push disks into a BBC Model

B, even how to call up the in-built routines within, but close questioning revealed they still lacked the basic understanding of what went on inside the box, and so our Interak friend got the job.

We have probably all met "mighty mouth", the computer science student from the local polytechnic. The computer **he** plays with is always much better than yours - he has 300 Megabyte disk drives, he can perform so many thousands more than you of floating point operations per second, his modem works at 9600 baud, and so on. Interak users who meet this person at computer clubs or in the pub enjoy a lot of sport at this poor soul's expense. In reality, he knows nothing of any use, and when you try him with a few practical problems he caves in and scampers off with his tail between his legs.

Another Interak user had some fun this way too. She was a technician whose job was to minister to the needs of a group of "mighty mouths" who were doing a course at the university where she worked. She had to get her qualifications in her spare time, whilst working for the young upstarts mentioned. The end of the story is that she is now in high demand as a highly regarded consultant, but the "mighty mouths" are out of work.

I do not mean to imply that building an Interak is the automatic way to double your salary and make a success in the world of computers; the people I mentioned would probably have done that anyway. What is significant is that they chose to do something positive in building their own computer, learning things in that way which could never be learned by sitting in a lecture theatre in front of a blackboard, or for that matter which could never be learned by sitting at the keyboard of even the most expensive computer in the land. People may say that if you want to build a computer yourself you must be mad. Very possibly you are, but at least with us you know you are among friends who are just as mad as you are!

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